



# U.S. - Russia Energy Working Group

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Russian Technologies



# Russian Technologies

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- Nuclear
- Battery and Fuel Cell Technology
- Fossil Fuel Technologies
- Other



# Nuclear

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- Large Scale Simplified boiling Water Reactor
- Pebble Bed Light Water Reactor with Micro-Fuel Elements
- Radkowsky Thorium Fuel (RTF) Concept.



# Battery and Fuel Cell Technology

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- New Materials development for fuel cells.
- Photon Battery
- Concentrator Modules Based on II-V Multijunction Solar Cells and Composite Fresnel Lenses
- Fuel Cell Component and System Development
- Development of Ultra-Lightweight Amorphous Silicon Alloy Photo-voltaics for Space Applications
- Development of PV Gas Recycling Technology for Solar Cell Production
- Development of Next Generation Building-Integrated Photo-voltaic Modules
- Ovonic Nickel Metal-Hydride (NiMH) Battery Technology



# Fossil Fuel Technologies

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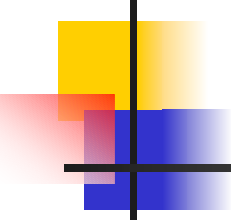
- Outside Rarefaction Shock Wave Cutter for Oil-Gas Platform Removal
- Retrofit and Demonstration of a Small Natural Gas Vehicle Fleet in a Nuclear City
- Development of Numerical Simulator for Improved Oil and Gas Production in Weak Reservoir Formations
- Radar Mapping of Geologic Structures from Drills
- Radar Mapping of Fractures in Hydrocarbon Reservoirs
- Drilling, Imaging and Coal Bed Methane Production Ahead of Mining



# Other

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- Low-Maintenance Wind Power System
- Catalytic Process for the Conversion of Scrap Tires to Reusable Rubber



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## Examples of Russian Technologies Selected from the Previous List

# Ovonic Nickel Metal-Hydrate (NiMH) Battery Technology



- Joint U.S.-Russian venture established production operations in Glazov
  - Russian metal alloy melting chambers produce ingots for negative electrodes in proprietary Ovonic NiMH batteries
  - Process improvements reduced capital equipment/overall manufacturing costs
  - Facility now producing test materials for possible use in batteries for wide range of applications, including hybrid electric vehicles and electric scooters
- Ovonic NiMH technology in widespread commercial use
  - Licensed manufacturers now produce >900 million NiMH batteries for laptops, cell phones, videocams
  - Russian-produced materials will help expand market

**Projected/Current Sales:**  
\$15 million/yr in 5 yrs (50% to Russians)

**Commercialization:**  
Mid-2003



Energy Conversion Devices, Inc.  
Troy, MI



Sovlux Battery  
Chepetsky Mechanical Plant  
Glazov, Russia

**ornl**

Oak Ridge National Laboratory  
Oak Ridge, TN



# Direct Carbonate Fuel Cell (DFC™)



- DFC™ promises clean, efficient, low-cost energy for new millennium
  - No noble metals used in fabrication processes
  - Simplified manufacture, assembly, and operation
  - Multi-fuel capabilities
  - High quality waste heat cogeneration
  - Ultra high efficiency fuel cell/turbine hybrid
- New coating process and alloy compositions replace expensive nickel-clad stainless steel bipolar plates; metal/ceramic composite material enhances anode performance
- Reduced cost will accelerate worldwide introduction of efficient DFC™
- Development of Russian capacity for DFC™ component production will
  - boost Russian civilian economy
  - help meet global need for environmentally-friendly energy source

**Projected/Current Sales:**  
\$27 Million

**Commercialization:**  
Field Trials since 2001



FuelCell Energy

FuelCell Energy, Inc.  
Danbury, CT

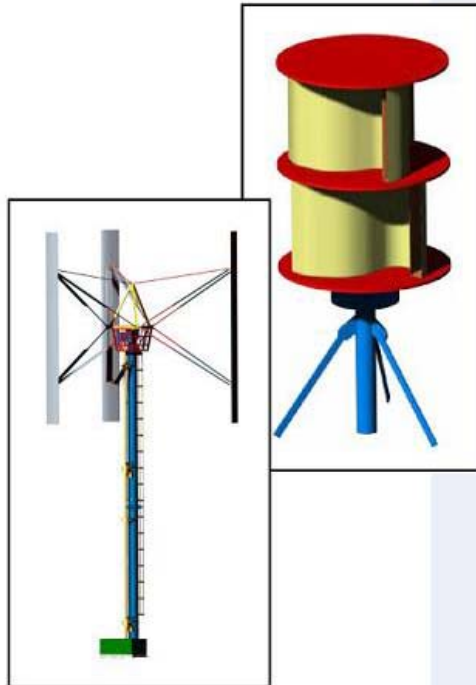


Arzamas-16  
Sarov, Russia



Argonne National Laboratory  
Argonne, IL

# Low-Maintenance Wind Power System



- Multi-billion dollar wind power generation industry growing in popularity
  - Need to reduce CO2 emissions
  - Need to generate electricity cost-effectively in remote locations for ranchers, farmers, villages, deep-well survival
- Small (3-70 kW) wind power system uses novel Vertical Axis Wind Turbine (VAWT) design
- VAWT offers advantages over conventional Horizontal Axis Wind Turbine
  - Lower maintenance costs
  - Increased durability and reliability
  - More economically viable in remote locations

**Projected/Current Sales:**  
\$80 Million

**Commercialization:**  
2004-2005

Empire Magnetics Inc.

Empire Magnetics, Inc.  
Rohnert Park, CA



State Rocket Center,  
Makeyev Design Bureau  
Miass, Russia



Lawrence Berkeley  
National Laboratory  
Berkeley, CA

# Rarefaction Shock Wave (RSW) Cutter for Offshore Oil-Gas Platform Removal



- Offshore oil/gas installations and sub-sea equipment must be removed when production ceases
  - Platforms stand in waters 10-3,000 feet deep
  - 50-80 lbs. of explosives needed for removal
  - Efficient techniques using less explosives only cut pipes up to 2 inches thick
- New Russian technology uses interaction of explosively-generated RSW to cut thick-walled cylindrical cross-section pipes
  - Technique requires only 9-15 lbs. of explosives
  - RSW cutter able to sever pipes several inches thick
  - RSW minimizes effects of underwater blasts on marine life
- U.S. partner will pursue offshore commercial market, starting with Gulf of Mexico and North Sea operations; Russian partner will develop other sizes/variants of RSW cutters

## Projected/Current Sales:

\$100K in year 3; \$1.3 million in year 5

## Commercialization:

2003



Jet Research Center Division  
Halliburton Energy Services, Inc.  
Alvarado, TX



Russian Federal Nuclear Center  
(Arzamas-16)  
Sarov, Russia



Lawrence Livermore  
National Laboratory  
Livermore, CA



# Metal Interconnect Materials for Solid Oxide Fuel Cells (SOFC)



- Bipolar plates in planar SOFC stacks separate air and fuel streams, electrically connect adjacent cells
  - Metallic separator plates are desirable for reduced cost, simpler pressure seal design
  - Metal separators must be oxidation resistant and/or oxide scale must be thin and electronically conducting
- Russian experts in alloy design/development will examine 2 new metal interconnect coatings:
  - Application of spinel to stainless steel
  - Use of custom-made homogenous materials
- Project will cover initial screens, pilot lot manufacturing runs
- Successful post-project commercial stack tests will help meet growing consumer demand for next generation fuel cells

**Projected/Current Sales:**  
TBD

**Commercialization:**  
2004



Materials and Systems  
Research, Inc.  
Salt Lake City, UT



Arzamas-16  
Sarov, Russia



Argonne National Laboratory  
Argonne, IL

## Retrofit and Demonstration of a Small Natural Gas Vehicle Fleet in a Nuclear City



- Air quality and environmental concerns, combined with limited supply and rising prices of petroleum, create growing global market demand for alternative fuels.
- Compressed natural gas (CNG) costs less than half of petroleum/gasoline on per-unit-energy basis.
- Dramatic technological advances allow CNG to burn cleanly in internal combustion engines.
- Trucks equipped with special tanks can reach and tap natural gas reserves — including stranded gas—more economically than expensive pipelines.
- CNG is source for 2nd tier industrial, commercial and residential markets.

**Projected/Current Sales:**  
\$60 million per year (4 yrs post-project)

**Commercialization:**  
2003



NEOgas, Ltd.  
Houston, TX



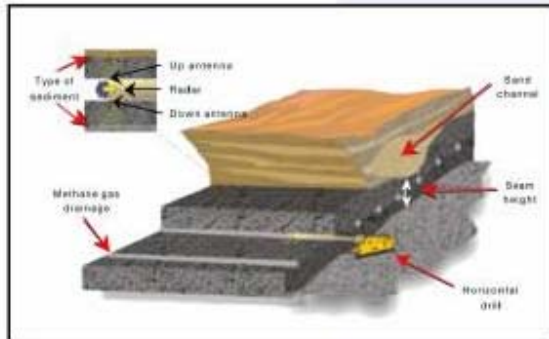
Azamas-16 (VNIIEF)  
Sarov, Russia



National Renewable Energy Laboratory  
Golden, CO

# Radar Mapping of Geologic Structures from Drills

- Mining of smaller/deeper deposits requires advance drilling to determine geologic structure and assess conditions



- Borehole radar is prototype technology for mapping anomalous geologic structures.
- Borehole radar unit is integrated into drill heads
  - Drillstring contains radio data transmission link
  - radar unit generates its own power
  - radar unit capable of withstanding severe environments
- Technology eliminates costly need to drill to floor and roof of boundary, with significant savings in electrical energy costs
- Possible urban area use for trenchless excavation to install/replace utilities

**Projected/Current Sales:**  
\$65 million in 5 years

**Commercialization:**  
Started



Horizon, Inc.

Raton, New Mexico



Institute for Measuring Systems Research  
(NIRS)

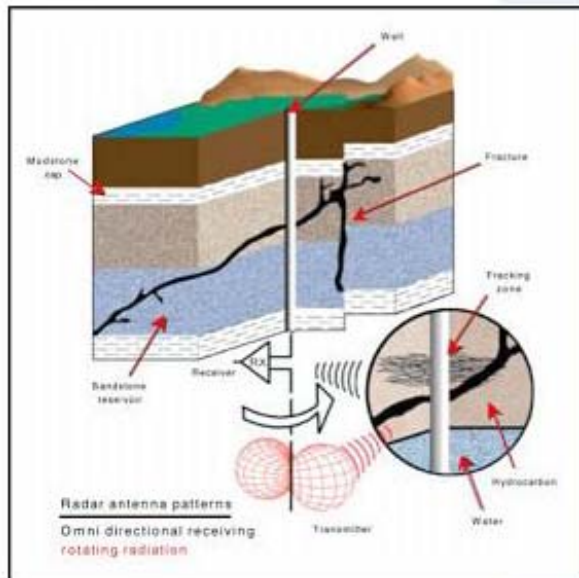
Nizhny Novgorod, Russia



Kansas City, Missouri



# Radar Mapping of Fractures in Hydrocarbon Reservoirs



- Radar antenna array and 400-kHz to 4-MHz band enables signals to propagate to distances beyond 10 meters from wellbore
- Radar data processed in high-resolution tomography algorithm
- Maps fractures and identifies fluid type
- High-resolution tomography software
- Imaging enables smart fracking and sealing to increase hydrocarbon recovery and oil/water ratio

**Projected/Current Sales:**  
\$2 billion per year

**Commercialization:**  
Started



Horizon, Inc.

Raton, New Mexico



Institute for Measuring Systems Research  
(NIIS)

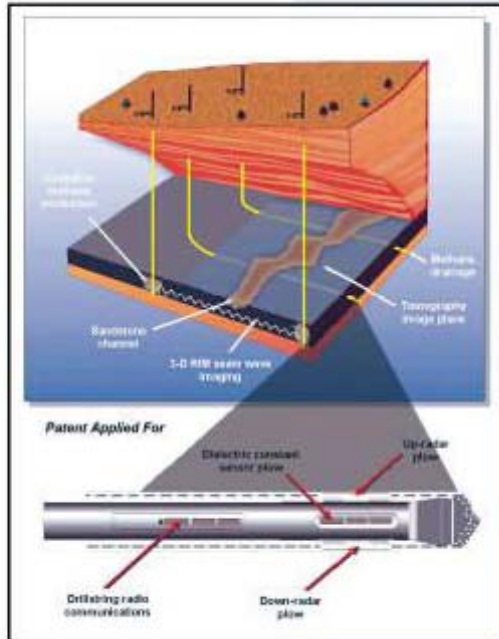
Nizhny Novgorod, Russia



Sandia  
National  
Laboratories

Sandia National Laboratories  
Albuquerque, New Mexico

# Drilling, Imaging and Coal Bed Methane Production Ahead of Mining



- Imaging geologic anomalies
  - Faults
  - Dikes and sills
  - Paleochannels
  - Altered coal
  - Old workings
  - Roof/floor rock type
- Coal bed methane
  - Determine flow interference
  - Determine seam height
  - Reduce CBM water
  - Reduce production cost
- Coal mining
  - De-gas seam ahead of mining
  - Reduced ventilation cost
  - Mine planning with geologic information
- Financial
  - Verification of financial projection
  - Low risk and financing cost

**Projected/Current Sales:**  
\$2 billion per year

**Commercialization:**  
Started



Horizon, Inc.

Raton, New Mexico



Sedakov Institute for Measurement  
Systems Research (NIFS)

Nizhny Novgorod, Russia



Kansas City, MO



# Radkowsky Thorium Fuel (RTF)



- RTF is a new fuel for the world's existing light water reactors.
- Nuclear power plants using RTF will be unable to produce nuclear weapons-usable plutonium in their spent fuel.
- The costs of RTF are projected to be lower than current fuels.
- The "back end" benefits of RTF include significantly reduced volume and weight of spent fuel, and reductions in high-level nuclear wastes.
- A business partnership that is expected to lead to a major export product from Russia.

**Projected/Current Sales:**  
In excess of \$100 million per year

**Commercialization:**  
2006



Thorium Power  
Washington, D.C.



Kurchatov Institute of Atomic Energy  
Moscow, Russia



Brookhaven National Laboratory  
Upton, NY